Catchment-scale conservation in the Ethiopian highlands: planning for more than just erosion control

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Introduction

Many soil & water conservation (SWC) projects aim to address the single goal of reducing soil loss from actively eroding areas. In this project, community discussions pointed to the need to additionally address seasonal water scarcity and water table lowering caused by land degradation and historically poor landscape management planning. While taking community priorities and preferences into account, we used a model to identify those places in the landscape most likely to be "responsive" to SWC activities. Here, "responsiveness" is defined as the potential to lead to an enhancement in two ecosystem services (ES's), erosion control and dry season baseflow. Erosion control can reverse yield decline by preventing the loss of topsoil and the nutrients therein. An increase in stream baseflow would benefit all water users and would allow for an expansion in irrigable capacity and/or more frequent irrigation.

Methods

I. The establishment of a baseline scenario compiled from:
   i. Community input: A training on satellite imagery enabled interactive identification of the locations of prior SWC activities and preferred sites for SWC activities.
   ii. Ground-truthing of land use/land covers (LULC) and erosion hotspots.
   iii. Remote sensing to identify LULCs.
   iv. Biophysical parameters derived from literature.

II. Creation of a "basket of activities" and set of "rules" governing their allocation.

III. Use of the Resource Investment Optimization System (RIOS) model to rank pixels acc. to 7 key factors that drive erosion and 8 that drive baseflow (Table 1).

IV. Predicting of LULC transitions (changes) where conservation is recommended.

V. Comparison of baseline ES status to predicted post-SWC ES status.

Table 1: Ranking of key factors linked to ES's

	Erosion control	Baseflow
maximize	Cover-factor Rainfall erosivity Soil depth Upslope sediment source Soil erodibility	Rainfall Soil depth Upslope runoff source
minimize	On-pixel soil retention Downslope soil retention	Actual ET Vegetative cover Soil texture Slope Surface roughness

Results

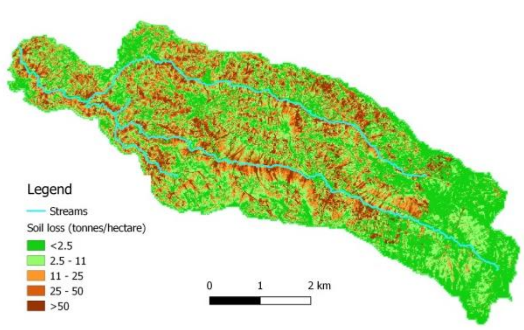

Fig. 1: Baseline (current) soil loss risk

Table 2: Predicted soil erosion risk for the catchment

	Baseline	After SWC
Ave. soil loss (t/ha)	20.6	13.4
Exported to streams (% of total)	7.8	6.2

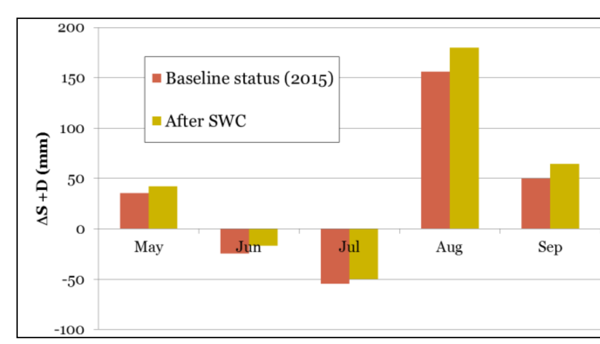

Fig. 3: Predicted changes in the soil water storage/drainage (ΔS+D) term of the water balance imply the likely enhancement of stream baseflow

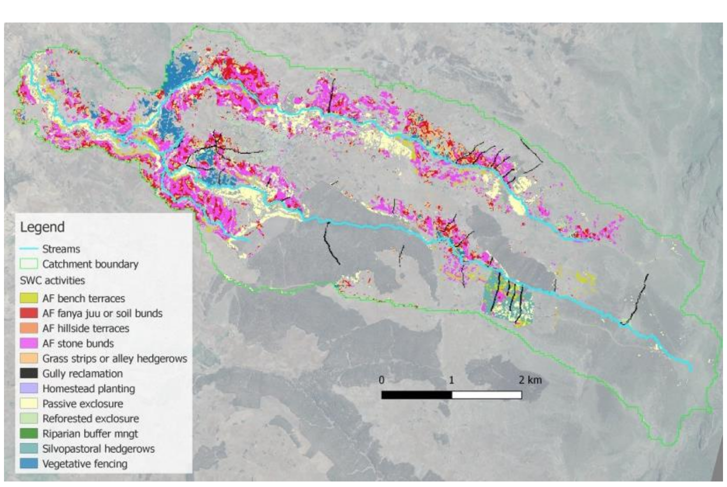

Fig. 2: The most "responsive" sites to SWC (600 ha benchmark) and the recommended activities

Conclusions

In many degraded highland areas, there is a need to address the deterioration of ES's. Seasonal water scarcity and erosion control are of particular concern in the study area. The RIOS approach is unique because it attempts to predict those "most responsive" sites from which the most benefits – onsite and offsite – can be obtained. In the scenario presented, soil loss is reduced by 35% and ΔS+D (a proxy for baseflow) is enhanced by 30% after 600 hectares are converted. By integrating ES outcomes into conservation planning, future planners may be enabled to compare predicted outcomes, for example, for scenarios that give different "weights" to ES's according to how they are valued by stakeholders. Despite some shortcomings of the available tools and the need to address incentives, it is hoped that future targeted SWC can account for offsite benefits like stream baseflow.

The project has been funded by the USAID under the Feed the Future Program of the Africa RISING project. CIAT is a partner of ILRI who is the primary recipient of the fund. The author was sponsored by GIZ.